

National Bureau of Standards

TECHNICAL NEWS BULLETIN

JUNE 1946

No. 350

Cooperative Program on Standard Samples of Hydrocarbons

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Early in 1943, the Petroleum Industry War Council requested the National Bureau of Standards to include hydrocarbons of high purity in its Standard Sample program. With the approval of Lyman J. Briggs, then Director of the Bureau, and G. E. F. Lundell, chief of the Chemistry Division, this work was begun July 1, 1943, in the Section on Thermochemistry and Hydrocarbons. Within a year, about 15 hydrocarbon Standard Samples had been completed. The needs of the industry for new hydrocarbon standards were mounting so rapidly, however, that a much greater rate of production was necessary. Accordingly, the Petroleum Industry War Council requested the American Petroleum Institute Advisory Committee on Fundamental Research on the Composition and Properties of Petroleum (J. Bennett Hill, chairman) to effect a cooperative program with the Bureau whereby there could be brought to bear on the problem all the facilities of the existing research projects of the Institute so that the preparation of finished hydrocarbon standards could be materially speeded up.

The program began operating formally on July 1, 1944, under the newly formed API Research Project 46 Committee on Hydrocarbons for Spectrometer Calibration (W. J. Sweeney, chairman, L. C. Beard, Jr., T. G. Delbridge, F. E. Frey, H. Gershinowitz, H. Levin, and R. F. Marschner, with H. J. Hall as secretary, and C. E. Board, M. R. Fenske, F. D. Rossini, and F. C. Whitmore as consultants). The cooperative program was operated according to the accompanying chart.

The American Petroleum Institute Hydrocarbon Research Project (now the API Research Project 45) at the Ohio State University (C. E. Board, supervisor) gave the enlarged program a flying start by contributing immediately a large number of hydrocarbon concentrates which it had on hand as the result of its work on the synthesis of hydrocarbons for automotive engine testing, and also began the synthesis of new compounds for the program.

The Hydrocarbon Laboratory and the API Research Project 42 at the Pennsylvania State College (F. C. Whitmore, supervisor) had laboratory facilities and

experienced investigators ready, and immediately began the synthesis of new hydrocarbons of the gasoline range. Contributions of material to the program were made by the National Advisory Committee for Aeronautics (through its laboratory at Cleveland), General Motors Corporation, the API Research Project 6, the Bureau's Automotive Section, and about 15 other laboratories, as listed in the chart, page 43.

The API Research Project 6 at the Bureau performed the final purifications and determinations of purity.

The sealing in vacuum in glass ampoules, certification, and packaging were performed by the Bureau's Hydrocarbon Standard Samples Laboratory.

In the cooperative program, the target for the final product was 1 liter of material of 99.8 mole percent purity for standard samples, plus 0.2 liter of material of higher purity for "API-NBS" samples. The API-NBS samples are a series of highest purity hydrocarbons, the preparation of which was begun in 1943 as a joint effort of the API Hydrocarbon Research Project (now the API Research Project 45) at the Ohio State University and the API Research Project 6 at the Bureau. These samples are available on loan to qualified investigators for the measurement of needed properties. The API-NBS samples and the data obtained from them, are handled through the API Research Project 44 at the Bureau on the "Collection, Analysis, and Calculation of Data on the Properties of Hydrocarbons."

In the accompanying table are listed the 71 compounds completed in the cooperative program on standard samples of hydrocarbons as of May 15, 1946, together with 19 compounds on the original NBS list, making a total of 90 hydrocarbon standards. In the cooperative program 32 additional compounds are in process of purification, 35 are on hand for purification, and 30 are in process of synthesis or purchase.

It is important to note that, with several exceptions, this cooperative program has resulted in much purer samples of these hydrocarbons than had ever before been prepared, and also in the preparation of several compounds which had never before been made.

The details of the work on the synthesis of hydrocarbons in the cooperative program by the API Research Project 45 on the "Synthesis and Properties of Hydrocarbons of Low-Molecular Weight" at the Ohio State University, under the supervision of C. E. Board, and by the API Research Project 42 on the "Synthesis and Properties of Hydrocarbons of High-Molecular Weight" and the Hydrocarbon Laboratory at the Pennsylvania State College, under the supervision of F. C. Whitmore, are given in scientific papers being prepared for publication by the groups of investigators in those laboratories.

The work on purification and determination of purity was performed by the API Research Project 6 at the Bureau, under the supervision of Frederick D. Rossini. Working full-time on the handling of these hydrocarbons, determining their purity by measurement of freezing points, measuring refractive indices, evaluating boiling points, etc., were Anton J. Streiff, Evelyn T. Murphy, Janice C. Cahill, Helen F. Flanagan, and four subprofessional assistants. All the distillations were performed by Charles B. Willingham, Vincent A. Sedlak, and seven subprofessional assistants. A detailed description of the purification, purity, and freezing points of these hydrocarbons is given in the scientific papers which are being prepared for publication by this group.

All of the personnel and facilities of the NBS Hydrocarbon Standard Samples Laboratory (which had been in operation since July 1, 1943) were brought into the cooperative program on July 1, 1944, with responsibility for the sealing in vacuum, certification, and packaging of the finished standard samples. Under the supervision of Frederick D. Rossini, the following personnel carried on the work of this laboratory: Beveridge J. Mair, Domenic J. Termini, Thomas A. Eble, Beryl A. Gaffney, Audrey H. Hull, and one subprofessional assistant. The operations involved in this part of the work are exacting in detail and require the utmost care to avoid contamination or loss of the final high-purity material. The hydrocarbons are completely degassed and are sealed in Pyrex glass ampoules under their own vapor pressure. The paraffin, cycloparaffin, and aromatic hydrocarbons are sealed in clear glass ampoules, and the olefin hydrocarbons in red glass ampoules. A complete description of the apparatus and procedure for sealing and packaging these standards is given in a scientific paper in process of preparation by this group.

NBS Hydrocarbon Standard Samples Nos. 201 to 218, inclusive, and No. 220 are obtainable only from the Bureau. All of the other standard samples, that is, No. 219 and those numbered 221 and higher, are obtainable either from the American Petroleum Institute or the Bureau. For the benefit of the cooperative program, inquiries for the latter compounds from petroleum laboratories should be sent to the American Petroleum Institute, whereas inquiries from all other laboratories should be sent to the Bureau. Petroleum laboratories should send their inquiries to the American Petroleum Institute, 50 West 50th Street, New



TECHNICAL NEWS BULLETIN

U. S. DEPARTMENT OF COMMERCE
Henry A. Wallace, *Secretary*

NATIONAL BUREAU OF STANDARDS
E. U. Condon, *Director*

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Contents

	Page
Cooperative program on standard samples of hydrocarbons	41
Chemical thermodynamic properties of monoolefin hydrocarbons	44
Crystallization of unvulcanized rubber	44
Ionization constant of boric acid	45
Serviceability of optical glasses	45
Fineness test of molding sand	45
Ceramic coating for alloys of high thermal expansivity	45
Nickel plating on steel by chemical reduction	46
Purification of rhodium plating baths	46
Magnetic materials	46
Prediction of maximum usable radio frequencies	46
Qualification testing of dry cells and batteries	46
Reorganization of Electricity Division	47
New and revised publications issued during May 1946	47
Mimeographed material: Letter Circulars	47
Recent articles by members of the Bureau's staff published in outside journals	47

York 20, N. Y. All other laboratories (and also the petroleum laboratories desiring the 19 Standard Samples available only from the Bureau) should send their inquiries to the National Bureau of Standards, Washington 25, D. C.

With a total of 90 different hydrocarbon compounds now available as standard samples, the API Committee on Hydrocarbons for Spectrometer Calibration considers its war-time emergency aims to have been fully achieved. The success of the cooperative program has resulted from the unselfish and enthusiastic efforts of the many chemists engaged in the work and the hearty cooperation of the industry, university, and government laboratories associated in the cooperative program. Although the API Committee on Hydrocarbons for Spectrometer Calibration will formally disband as of June 30, 1946, arrangements will be made for the completion by the API Research Project 6 and the Hydrocarbon Standard Samples Laboratory at the Bureau, of the nearly 100 compounds that will remain. On the final completion of the cooperative program, the NBS Hydrocarbon Standard Samples Laboratory will resume its regular work in this field.

AMERICAN PETROLEUM INSTITUTE AND NATIONAL BUREAU OF STANDARDS
COOPERATIVE PROGRAM ON HYDROCARBONS FOR SPECTROMETER CALIBRATION

AMERICAN PETROLEUM INSTITUTE ADVISORY COMMITTEE ON FUNDAMENTAL RESEARCH
ON THE COMPOSITION AND PROPERTIES OF PETROLEUM

ORGANIZATION OF THE COOPERATIVE PROGRAM
BY THE A.P.I. RESEARCH PROJECT 46 COMMITTEE ON HYDROCARBONS FOR SPECTROMETER CALIBRATION

PROVISION OF MATERIALS

BY THE

AMERICAN PETROLEUM INSTITUTE
RESEARCH PROJECT 45
AT THE
OHIO STATE UNIVERSITY
BY SYNTHESIS
WITH PRELIMINARY PURIFICATION

BY THE

HYDROCARBON LABORATORY
AND THE
A.P.I. RESEARCH PROJECT 42
AT THE
PENNSYLVANIA STATE COLLEGE
BY SYNTHESIS
WITH PRELIMINARY PURIFICATION

BY THE A.P.I. RESEARCH PROJECT 6 AT THE NATIONAL BUREAU OF STANDARDS
BY PURCHASE OR PROCESSING OF COMMERCIAL MATERIAL

AND BY OTHER LABORATORIES FROM STOCKS ON HAND OR BY SYNTHESIS
ATLANTIC REF. CO. HUMBLE OIL SOCONY-VACUUM
CALIF. RES. CORP. NATL. ADV. COMM. AERO. STD. OIL DEV.
CARBIDE AND CARBON NATL. BUR. STANDARDS STD. OIL (INDIANA)
ETHYL CORP. PHILLIPS PETROLEUM STD. OIL (OHIO)
GENERAL MOTORS RUBBER RESERVE TIDE WATER ASSOC.
GULF-MELLON INST. SHELL DEV. UNIV. OIL PROD.
HOUDRY PROCESS SHELL OIL

FINAL PURIFICATION AND DETERMINATION OF PURITY

BY THE A.P.I. RESEARCH PROJECT 6 AT THE NATIONAL BUREAU OF STANDARDS

SEALING IN VACUUM, CERTIFICATION, AND PACKAGING

BY THE HYDROCARBON STANDARD SAMPLES LABORATORY AT THE NATIONAL BUREAU OF STANDARDS

DISTRIBUTION OF SAMPLES

BY THE
AMERICAN PETROLEUM INSTITUTE
TO LABORATORIES
IN THE PETROLEUM INDUSTRY

BY THE
NATIONAL BUREAU OF STANDARDS
TO ALL OTHER
LABORATORIES

STANDARD SAMPLES OF HYDROCARBONS

(Complete details as to types of containers, sizes of samples, prices, etc., may be obtained on application.)

PARAFFINS

<i>n</i> -Pentane.	2,2-Dimethylhexane.
Isopentane.	2,3-Dimethylhexane.
Neopentane.	2,4-Dimethylhexane.
<i>n</i> -Hexane.	2,5-Dimethylhexane.
2-Methylpentane.	3,3-Dimethylhexane.
3-Methylpentane.	3,4-Dimethylhexane.
2,2-Dimethylbutane.	2-Methyl-3-ethylpentane.
2,3-Dimethylbutane.	3-Methyl-3-ethylpentane.
<i>n</i> -Heptane.	2,2,3-Trimethylpentane.
2-Methylhexane.	2,2,4-Trimethylpentane.
3-Methylhexane.	2,3,3-Trimethylpentane.
3-Ethylpentane.	2,3,4-Trimethylpentane.
2,2-Dimethylpentane.	<i>n</i> -Nonane.
2,3-Dimethylpentane.	2,2,5-Trimethylhexane.
2,4-Dimethylpentane.	2,4,4-Trimethylhexane.
3,3-Dimethylpentane.	2,2,3,3-Tetramethylpentane.
2,2,3-Trimethylbutane.	2,2,3,4-Tetramethylpentane.
<i>n</i> -Octane.	2,2,4,4-Tetramethylpentane.
2-Methylheptane.	2,3,3,4-Tetramethylpentane.
3-Methylheptane.	3,3-Diethylpentane.
4-Methylheptane.	<i>n</i> -Decane.
3-Ethylhexane.	

ALKYLBENZENES

Benzene.	1-Methyl-3-ethylbenzene.
Toluene.	1-Methyl-4-ethylbenzene.
Ethylbenzene.	1,2,3-Trimethylbenzene.
<i>o</i> -Xylene.	1,2,4-Trimethylbenzene.
<i>m</i> -Xylene.	1,3,5-Trimethylbenzene.
<i>p</i> -Xylene.	<i>n</i> -Butylbenzene.
<i>n</i> -Propylbenzene.	Isobutylbenzene.
Isopropylbenzene.	<i>sec</i> -Butylbenzene.
1-Methyl-2-ethylbenzene.	<i>tert</i> -Butylbenzene.

ALKYLCYCLOPENTANES

Cyclopentane.	<i>n</i> -Propylcyclopentane.
Methylcyclopentane.	Isopropylcyclopentane.
Ethylcyclopentane.	1,1,2-Trimethylcyclopentane.
1,1-Dimethylcyclopentane.	1,1,3-Trimethylcyclopentane.
<i>cis</i> -1,2-Dimethylcyclopentane.	<i>c,c</i> -1,2,4-Trimethylcyclopentane.
<i>trans</i> -1,2-Dimethylcyclopentane.	<i>c,t,c</i> -1,2,4-Trimethylcyclopentane.
<i>trans</i> -1,3-Dimethylcyclopentane.	

ALKYLCYCLOHEXANES

Cyclohexane.	<i>cis</i> -1,2-Dimethylcyclohexane.
Methylcyclohexane.	<i>trans</i> -1,2-Dimethylcyclohexane.
Ethylcyclohexane.	<i>cis</i> -1,4-Dimethylcyclohexane.
1,1-Dimethylcyclohexane.	<i>trans</i> -1,4-Dimethylcyclohexane.

MONOOLEFINS

1-Pentene.	3-Methyl-1-butene.
<i>cis</i> -2-Pentene.	2-Methyl-2-butene.
<i>trans</i> -2-Pentene.	3,3-Dimethyl-1-butene.
2-Methyl-1-butene.	Cyclopentene.

Chemical Thermodynamic Properties of Monoolefin Hydrocarbons

In the June number of the Journal of Research, John E. Kilpatrick, Edward J. Prosen, Kenneth S. Pitzer,

and Frederick D. Rossini present a report (RP1722) on the chemical thermodynamic properties of the monoolefin hydrocarbons. This was prepared as part of the work of the American Petroleum Institute's Research Project 44 at the Bureau.

For ethylene, propylene, each of the four butenes, six pentenes, and 17 hexenes, and for the higher normal 1-alkenes, values are presented for the following thermodynamic properties to 1,000° K or to 1,500° K: The heat of formation from the elements, ΔH_f° ; the free-energy formation from the elements, ΔF_f° ; and the logarithm of the equilibrium constant of formation from the elements, $\log_{10} K_f$. For each of the six pentenes and 17 hexenes, values are also given to 1,000° K or to 1,500° K, for the following properties: The heat content function, $(H^\circ - H^\circ_0)/T$; the free energy function, $(F^\circ - F^\circ_0)/T$; the entropy, S° ; the heat content, $H^\circ - H^\circ_0$; and the heat capacity, $C^\circ p$.

Equilibrium constants and concentrations are given in tabular and graphical form for the isomerization of the four butenes, six pentenes, and 17 hexenes, as a function of the temperature to 1,000° or 1,500° K. Equilibrium constants are also given in tabular and graphical form for some reactions of hydrogenation, dimerization, and alkylation.

Crystallization of Unvulcanized Rubber

Natural rubber is commonly classed as an amorphous substance and regarded as distinctly different from those classed as crystalline. However, under the proper conditions—usually involving cooling or stretching, or both—rubber exhibits all the phenomena to be expected in the formation and melting of a polycrystalline material. Crystallization and fusion are made manifest by changes in specific volume, specific heat, light absorption, birefringence, X-ray diffraction, and mechanical properties. Studies of crystallization in rubber, using a number of these techniques, have been made at the Bureau.

In the May issue of the Journal of Applied Physics and in the Journal of Research for June (RP1718), Lawrence A. Wood and Norman Bekkedahl give the results of a series of quantitative studies of the crystallization of unvulcanized rubber as a function of temperature. Conditions that might influence the results were purposely kept as simple as possible. The main features of the crystallization of vulcanized rubber have already been shown to be similar to those of unvulcanized rubber, the vulcanization merely causing a decrease in the rate.

Stretching obviously adds complications to the experimental conditions, and so was not employed. Change of volume, as measured in a mercury-filled glass dilatometer, was chosen as the simplest method of measuring crystallization, and the one most likely to yield quantitative data about the course of crystallization or fusion.

Crystallization was observed to occur at temperatures between -50° and $+15^{\circ}$ C, and to be most rapid at about -25° C. The final decrease of volume on crystallization was usually found to lie between 2.0 and 2.7 percent.

The melting of crystalline rubber was found to occur over a range of temperatures, and to be closely related to the temperature at which the crystals were formed. The temperature at which the beginning of melting occurs is from 4 to 7 degrees above the temperature of crystallization. The range of melting is about 35 degrees at the lowest temperatures and decreases to about 10 degrees at the highest. The same range of temperature of melting is obtained, regardless of the extent of the crystallization.

The nature of the crystalline regions in long-chain high polymers has been the subject of considerable discussion in recent years. It seems generally agreed that the structural units of the crystallites are not whole molecules, but rather kinetic units that are segments of chains. Consequently, a single chain may contain segments that are units in two or more different crystallites, joined by segments that are to be regarded as part of the amorphous material. However, no detailed picture has been proposed that logically and satisfactorily explains the fact that the range of melting is not dependent on the extent of crystallization and that it is definitely determined by the temperature at which crystallization occurs.

Ionization Constant of Boric Acid

Solutions of borax of various concentrations are widely used as alkaline buffer standards. In a continuation of work reported previously in Technical News Bulletin No. 330 (October 1944), George G. Manov, Nicholas J. DeLollis, Phoebe W. Lindvall, and S. F. Acree investigated the effect, from 0° to 60° C, of sodium chloride on the ionization constant and the pH values of solutions of boric acid and sodium borate, added together as borax. It was found that the pH value of the solution was lowered by the addition of sodium chloride. These measurements permit a simplification, without loss of accuracy, in the preparation of buffer solutions of known pH value. The experimental details, comparison with the work of earlier investigators, and recommendations for the calibration of pH equipment are given in the June number of the Journal of Research (RP1721).

Serviceability of Optical Glasses

The pH responses of electrodes prepared from glasses of widely different compositions have been compared with the hygroscopicity of the glasses (Technical News Bulletin No. 348 (April 1946)). The results, which are given in a report (RP1719) by Donald

Hubbard in the June Journal of Research, strongly support the belief that adequate hygroscopicity is a primary factor in determining the suitability of a glass for pH measurements. The data also suggest that the pH response might well be used as a measure of the serviceability of optical glasses, i. e., their ability to maintain a clear polished surface upon exposure to the atmosphere.

Fineness Test of Molding Sand

The fineness of a foundry sand is measured by the size and distribution of its particles. It is well recognized that the present sand fineness-test method of the American Foundrymen's Association is not entirely satisfactory, as sands with the same AFA classification may have different properties. The AFA method permits the classification of sand particles 53 microns in diameter or larger by means of a regular sieve test, but it fails to determine the fineness of the subsieve sand particles. Procedures such as the hydrometer method and the pipette method are available for this purpose, but thus far no comparative data based on the results obtained when these methods are applied to foundry sands, have been available.

In an investigation recently completed by Margaret Price and A. I. Krynetsky, fineness determinations of the subsieve particles in Albany and Lumberton molding sands were made by the hydrometer method, the regular pipette method, and the Andreassen pipette method. Each of these methods involves a study of sedimentation and the application of Stokes' law. The concentration of solid particles still in suspension at a certain level is determined at intervals during the course of the free settling of the suspension, and the resulting data permit the plotting of a curve showing the distribution of the fine particles in the sand.

The results obtained by the three methods which are given in the June Journal of Research (RP1720) are in excellent agreement. However, the hydrometer method is preferable because it yields satisfactory results conveniently with a minimum expenditure of time.

Ceramic Coating for Alloys of High Thermal Expansivity

The common heat-resisting alloys have thermal expansivities ranging up to nearly 50 percent higher than that of ordinary steel; hence, porcelain enamels or ceramic coatings for use on these alloys should have correspondingly higher expansivities in order to minimize stresses conducive to failure. The usual modifications in composition of enamel frits to increase their expansivities are limited in extent by the fact that they are accompanied also by undesirable changes in other properties of the coatings.

One method of building up the expansivity of the coating without modifying the frit itself is to introduce an admixture of high thermal expansivity. The Enam-

eled Metals Section of the Bureau has recently developed a ceramic coating of this type that has a mat (non-glossy) finish. It can be applied to 18-8 stainless steel in thicknesses up to 0.035 inch. This coating is produced by adding fluorspar (CaF_2) to a refractory enamel frit, ball-milling to a suitable fineness, applying the resulting water suspension to the cleaned metal by either dipping or spraying, and finally heating the coated piece in a furnace at $1,600^\circ$ to $1,700^\circ$ F for a period of four or five minutes.

Possible uses of this coating include several specialized applications, such as areas of alloy steel assemblies requiring a moderate degree of either thermal or electrical insulation. The new coating is of a refractory type, but at temperatures above a red heat, there is a slow attack by the coating on the alloy.

Nickel Plating on Steel by Chemical Reduction

A process developed by Abner Brenner and Grace E. Riddell of the Bureau's Electrochemistry Section for the nickel-plating of steel without the use of an electric current, will be described in a paper to be presented by Dr. Brenner at a meeting of the American Electroplaters Society in Pittsburgh on June 17. The deposition is brought about by the chemical reduction of a solution of a nickel salt with hypophosphites. The reaction is catalyzed by steel and nickel, and deposition of nickel occurs only on the surfaces of these metals. Because of its cost this process will not displace electrodeposition, but it should have certain special applications, such as the plating of articles that can not be electroplated satisfactorily.

Purification of Rhodium Plating Baths

Thin coatings of rhodium, when electrodeposited under proper conditions, have a reflectivity of approximately 75 percent and are very resistant to tarnish. This combination of properties makes rhodium electrodeposits very desirable as coatings on searchlight reflectors and also useful in the jewelry industry. Rhodium plating baths contain from 1 to 2 grams of rhodium, as the complex phosphate, 7 milliliters of phosphoric acid, and 25 milliliters of sulfuric acid per liter. When properly operated such baths will last for long periods of time and still produce excellent coatings, but, if the bath becomes contaminated through accident or long use, inferior coatings that are dark or cracked are obtained. Owing to the high cost of rhodium, it is necessary to reclaim the contaminated bath either by returning it to the vendor for purification or to purify the solution at the plating establishment.

A simple method, one that can be used even in a plating shop, for reclaiming the contaminated baths has been developed by Abner Brenner and Walter A. Olson,

of the Bureau's Electrochemistry Section. The undesirable metallic impurities are precipitated with potassium ferrocyanide and removed by filtration. The rhodium in the complex phosphate is not precipitated under the conditions of purification.

Magnetic Materials

An error occurs in the item "Naval Technical Mission to Japan" on page 27 of Technical News Bulletin No. 348 (April 1946). In the second paragraph, the second sentence should read "Among these were scientists of international reputation, including K. Honda, inventor of the well-known KS and new KS permanent-magnet alloys; T. Mishima, who developed MK alloy, the forerunner of the alnico alloys; and Y. Kato and T. Takei, who originated the sintered oxide type of magnet material."

Prediction of Maximum Usable Radio Frequencies

The prediction of maximum usable frequencies for radio transmission has always been based essentially on a correlation between critical frequencies at any time during a month and the 12-month running average of sunspot numbers. The usual practice has been to obtain these correlations for each ionosphere observing station for which sufficient data were available.

The Bureau's Central Radio Propagation Laboratory has evolved a new type of nomogram that improves the methods of making these predictions. Its principles were described in report IRPL-R11, "A nomographic method for both prediction and observation correlation." Recently, nomograms of this type were completed for all the months of the year, for all the main ionosphere stations, with the result that world prediction charts of ionospheric data, such as appear in the IRPL-D reports—"Basic radio propagation predictions", can now be made in half the time formerly required. The new type nomograms are presented in a report of the CRPL entitled "Nomogram relating gyrofrequency, ordinary-ray critical frequency, and extraordinary-ray critical frequency."

Qualification Testing of Dry Cells and Batteries

The so-called quick tests made on dry cells and dry batteries give little information about the service output or relative merits of various brands. The test that best represents any particular service is that which most nearly duplicates the rate-of-energy output of the battery in actual use. Intermittent tests are preferred to continuous tests, since there is no direct relation between the results of continuous tests and intermittent tests of longer duration.

Twenty years ago, the Bureau undertook the qualification testing of dry batteries, selecting the samples

periodically at the manufacturers' plants and subjecting the batteries to a complete program of tests in accordance with the Federal specifications. The results were supplied to the various Government departments, and each manufacturer was informed of the results of tests on his own product. This service was necessarily suspended during the war. It is now to be resumed at the request of several Government agencies and manufacturers. In reconverting the equipment, the control apparatus is being modernized.

Reorganization of Electricity Division

As of May 1, a major reorganization of the Bureau's Division of Electricity went into effect. The measurement work of the former Section on Radio Measurements was merged with the expanded work of the Inter-service Radio Propagation Laboratory (Division XIV) under J. H. Dellinger (Technical News Bulletin No. 349 (May 1946)). The work on interior ballistics for the Navy Department, which is being carried on under the leadership of H. L. Curtis, was transferred to the Ordnance Development Division (XIII), thus further concentrating the military work of the Bureau into a single division under H. Diamond.

E. C. Crittenden relinquished his duties, after 25 years of service, as chief of the Division of Electricity in order to devote his full time to his increasing responsibilities as Assistant Director. In his place, F. B. Silsbee has been designated chief of the Division. Charles Moon takes over from H. L. Curtis the duties of chief of the Inductance and Capacitance Section, and F. M. Defendorf becomes chief of the Instruments Section. Chester Snow is detached from the Inductance and Capacitance Section and assigned as mathematical consultant to the chief of the division.

New and Revised Publications Issued During May 1946

JOURNAL OF RESEARCH¹

Journal of Research of the National Bureau of Standards, volume 36, number 3, March 1946 (RP1700 to RP1704, inclusive). Price 30 cents. Annual subscription, 12 issues, \$3.50.

RESEARCH PAPERS¹

(Reprints from February 1946 Journal of Research)

RP1693. Heat capacity of a two-phase system, with applications to vapor corrections in calorimetry. Harold J. Hoge. Price 5 cents.

RP1694. A method for determining small amounts of gold, and its use in ascertaining the thickness of electrodeposited gold coating. W. Stanley Clabaugh. Price 5 cents.

RP1695. Purification and properties of 29 paraffin, 4 alkylcyclopentane, 10 alkylcyclohexane, and 8 alkylbenzene hydrocarbons. Alphonse F. Forziati, Augustus R. Glasgow, Jr., Charles B. Willingham, and Frederick D. Rossini. Price 5 cents.

RP1696. Effect of some added materials on dicalcium silicate. Edwin S. Newman and Lansing S. Wells. Price 10 cents.

RP1697. Reproducibility of the lead electrode and the electromotive force of the lead stick-lead amalgam cell at 0° to

60° C. Roger G. Bates, Murray Edelstein, and S. F. Acree. Price 5 cents.

RP1698. Engine tests with producer gas. Frederic A. Middleton and Clarence S. Bruce. Price 5 cents.

RP1699. Phase equilibrium relations in a portion of the system $\text{Na}_2\text{O}-\text{CaO}-\text{Al}_2\text{O}_3-\text{SiO}_2$. Kenneth T. Greene and R. H. Bogue. Price 10 cents.

SIMPLIFIED PRACTICE RECOMMENDATIONS¹

R214-45. Metal-cutting band saws (Hard edge, flexible back). Price 5 cents.

TECHNICAL NEWS BULLETIN¹

Technical News Bulletin 349, May 1946. Price 5 cents. Annual subscription, 50 cents.

Mimeographed Material

LETTER CIRCULARS

(Letter Circulars are prepared to answer specific inquiries addressed to the National Bureau of Standards, and are sent only on request to persons having a definite need for the information. The Bureau cannot undertake to supply lists or complete sets of Letter Circulars or send copies automatically as issued.)

LC821. Cathodic protection of underground structures—abstracts.

LC824. Structural clay products, stone, and masonry: Publications by members of the staff of the National Bureau of Standards, together with a list of Federal Specifications. (Supersedes LC643)

Recent Articles by Members of the Bureau's Staff Published in Outside Journals²

The 24 hour question. Ralph E. Gould. H. I. A. Journal (Horological Institute of America, 421 State Life Bldg., Indianapolis 4, Ind.) 2, No. 1, 9 (April 1946)

Measurement of ultraviolet radiation useful in heliotherapy. W. W. Coblenz. J. Optical Soc. Am. (57 East 55th St., New York 22, N. Y.) 36, No. 2, 72 (February 1946) (Address on presentation to Dr. Coblenz of the Frederic Ives Medal for 1945)

Report on buffer solutions. George G. Manov. J. Official Agricultural Chemists (Box 540, Benjamin Franklin Station, Washington, D. C.) 23, No. 3, 597 (August 1945)

The pH of some standard buffer solutions from 0 to 60 C, and the calibration of glass electrode pH meters. George G. Manov and S. F. Acree. ASTM Bul. No. 137 (American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa.) (December 1945)

Water vapor permeability tester. F. T. Carson and Vernon Worthington. Paper Industry and Paper World (59 East Van Buren St., Chicago, Ill.) 27, No. 12, 1799 (March 1946)

Air-conditioning in printing plants. C. G. Weber. Refrigerating Data Book—Applications. Second edition, chapter 72, p. 638 (Book published by American Society of Refrigerating Engineers, 40 West 40th St., New York, N. Y.) (1946)

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